

Aus der Medizinischen Universitäts-Klinik Basel
(Vorsteher: Prof. Dr. F. Koller)
Arbeit unter Leitung von Prof. Dr. W. Schweizer

Kinetocardiography In Acute Coronary Artery Disease

Inaugural-Dissertation

zur Erlangung der Doktorwürde
der Medizinischen Fakultät der Universität Basel

vorgelegt von

Hubert H. Yoder
von Washington/USA

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Introduction

Ultra-low frequency vibrations originating from the contracting heart are easily detected on the anterior chest wall. Registration of the precordial movements with an externally fixed pickup device constitutes a kinetocardiogram (KCG). This record of absolute precordial displacement differs from those tracings obtained with a pickup device placed directly on the thoracic wall (apexcardiography).

A study of 51 normal men between 16 and 30 years of age by this Department has permitted adequate definition of the normal KCG (von Bertab, Reist, and Schweizer, 1963). The KCGs of 30 were found to have similar shapes, relative size of amplitudes, and time intervals; the other 21 exhibited only minor deviations.

Characteristics of the normal KCG are: a small outward movement during atrial systole (A); minor and variable movements during isometric contraction; short outward movement (E) at the beginning of the ejection period, which is dominated by a retraction (R); outward movement in protodiastole (D) and, beginning at the time of A—V valve opening a filling wave (F).

The kinetocardiography in chronic coronary artery disease has been investigated and discussed by several authors (Harrison and Hughes, 1958; Eddleman and Langley, 1962; Schweizer, von Bertrab, and Reist, 1965). In an investigation by this Laboratory, large A waves and abnormal systolic outward movements were found in approximately 80 % of the cases (Schweizer, von Bertrab, and Reist, 1965).

According to the writer's knowledge, no kinetocardiographic studies have been done on patients with acute coronary artery disease. This article presents the various types and frequencies of kinetocardiographic abnormalities found in patients with uncomplicated myocardial infarction within three days after occurrence and during the period of recovery.

Subjects and Methods

Twenty patients, two females and eighteen males, between 39 and 72 years of age, were chosen for this study.

Fresh myocardial infarctions were confirmed by ECG in all cases. There were 8 cases of diaphragmatic infarction, 6 of the anterior wall. The remaining 6 had extensive infarctions, not permitting exact localization of the infarct.

Only those patients who were found to be essentially free of complications were accepted for this study. All 20 subjects had normal sinus rhythm and none showed clinical signs of shock or heart failure. Ten of the 20 patients investigated had no previous history of cardiovascular disease. Ten reported having had angina pectoris of mild to medium intensity for the last three to four years. Two had had confirmed myocardial infarctions before, one in 1960, the other in 1961. A questionable diagnosis of previous coronary occlusion in two others could not be documented by ECGs available to us.

One female had been hypertensive for the last 30 years (blood pressure 190/100 mm. Hg.), and 2 males gave a history of mild systolic blood pressure elevation (180/90 and 170/85 mm. Hg.) for the last four to five years.

No other heart disease was found in any patient investigated.

Kinetocardiograms were taken, employing the technique previously described (von Bertrab et al., 1963), from the following locations on the chest wall: K1/4, K2/4, K3/4, K4/4, K3/5, K4/5, and K sternum (over the distal end of the xiphoid process), and the point of maximum impulse when present.

Four serial recordings were made for each patient: an initial tracing taken within three days after occurrence of cardiac infarction and then repeated in ten day intervals for the first thirty days. A last registration was made on 16 of these patients four to nine months later.

Results

1. Overall results

These results are shown in Table 1.

The following abnormalities were found:

a) Large A waves (more than 20 % of the total amplitude) (Fig. 1a).

b) Large presystolic outward movement (Presystolic outward movements are small and variable in normal KCGs; this movement was designated large only when a considerable increase in size and obvious differences from normal tracings were seen) (Fig. 2 and 3).

c) Large E waves (greater than 0.08 seconds duration and less than 30 % of the total amplitude) (Fig. 4).

d) Small E waves and small retraction (Fig. 5).

e) Outward movement during systole (more than 30 % of the total amplitude). These movements were designated in accordance with their time occurrence in the cardiac cycle as early-, or pansystolic. (Fig. 6, 1a, 7).

f) Large D waves (more than 50 % of the total amplitude) (Fig. 8).

2. Changes in time

a) Large A waves: Large A waves were present in the first KCG in 90 % of the cases. Maximum height of these waves was noted within the first three days following myocardial infarction in 4 of 19 cases. In 3 others, these waves were found to be highest ten days after myocardial infarction. In 5 others, maximum height was observed twenty days after the occurrence of cardiac infarction. In the remaining 7, there was a continuous increase in the height of the A waves during the first month.

After attaining maximum height, the large A waves progressively diminished in size during the recovery period. (Fig. 1a, 1b and 1c). A progressive decrease in the frequency of these waves occurred also. Large A waves were still present in 56 % of the patients four to nine months later.

b) Large presystolic outward movement: Large presystolic outward movements were present in the first KCG in 50 % of the cases. No changes were noted.

c) Large E waves: Large E waves were present in the first KCG in 55 % of the cases. In five of eleven cases these waves occurred within the first ten days and had diminished to normal size after thirty days. In three others, these waves first appeared or became more prominent at the end of the first month. In the remaining three, large E waves were seen in the initial KCG and remained unchanged during the first thirty days. The situation was unchanged four to nine months later.

d) Small E waves and small retraction: Small E waves and small retraction were present in the first KCG in 40 % of the cases. No changes were noted.

e) Systolic outward movements: Early systolic outward movements were present in the first KCG in 20 % of the cases, mid-systolic outward movements in 70 % of the cases, and pansystolic outward movements in 35 % of the cases. The frequency and magnitude of the various systolic outward movements remained relatively constant throughout the first thirty days and the following four to nine months. During the first thirty days, pansystolic outward movements were replaced with early systolic or mid-systolic outward movements in three cases, and disappeared entirely in two others. Four to nine months later pansystolic outward movements were replaced with early systolic and mid-systolic movements in two additional cases.

f) Large D waves: Large D waves were present in the first KCG in 45 % of the cases. No changes were noted.

3. Kinetocardiograms taken from different locations

A few differences were observed in kinetocardiographic patterns taken from various points on the thoracic wall. Large A waves and large presystolic outward movements were fairly equally distributed in all locations.

With the exception of pansystolic outward movements, which were confined to the K2/4, K3/4, K4/4, K3/5, and K4/5 areas, the other types of systolic outward movement occurred in all seven chest wall regions explored. The highest incidence of early systolic outward movements was found in the K4/4 position, whereas mid-systolic outward movements occurred with significantly greater frequency in the K1/4 and K-sternal regions.

Most of the wide E waves were limited to the K3/4, K3/5, and K4/4 positions.

4. Correlations between kinetocardiographic findings and the site of myocardial infarction

No correlation existed between the site of the infarction and the different types of kinetocardiographic abnormalities found.

No correlation existed between the site of the infarction and KCGs taken from various points.

Discussion

The kinetocardiographic abnormalities present after fresh myocardial infarction are identical with those found in chronic coronary artery disease and occur with about the same frequency. Large A waves and outward movements during systole are the two main and most consistent abnormalities seen. A striking change observed in one-half of the patients studied was a large presystolic outward movement. This finding does not seem to have been reported by other investigators. This movement is very prominent and occurs too late in the cardiac cycle (extending to and through the beginning of the first heart sound) to attribute it to atrial activity. Small presystolic outward movements have been observed in kinetocardiograms of a few normal subjects (unpublished observations by this Department). These alterations were found to be present immediately after occurrence of myocardial infarction.

These changes are not peculiar to myocardial infarction alone. Large A waves are present in congestive heart failure, disappearing after therapy. Mid-systolic outward movements and large D waves are often seen in cases of angina pectoris without electrocardiographic or direct evidence of myocardial infarction. Therefore, the diagnostic value of kinetocardiography is presently unknown.

The earliest records available are three days after occurrence of myocardial infarction. Inasmuch as 10 of the 20 patients suffered from angina pectoris prior to occurrence of cardiac infarction, the interpretation and any conclusions drawn should be considered in light of the fact that kinetocardiographic changes could very well have been present before the first registration was made.

The pathogenesis of these alterations is only partially known. The large A waves seem to have a hemodynamic origin, probably being caused by atrial contraction in the presence of an abnormal

enddiastolic ventricular pressure. The frequent appearance of these A waves and the subsequent decrease in their frequency seem to indicate that heart failure (although clinically inapparent) is present in the very early stages of cardiac infarction in the majority of cases, remains for some time, and may then eventually disappear.

The pathogenesis of the other abnormalities is still unknown. The relation to functional aneurysms of the ventricular wall has been discussed previously.

Several men in the group of patients in whom pansystolic outward movements disappeared had always been very active physically. One of these men was a mountain climber. An interesting speculation might be that establishment of collateral circulation had resulted in a partial disappearance or decrease in the magnitude of these paradoxical outward movements.

The KCG records these abnormal outward movements, which may sometimes be detected by palpation of the anterior chest wall. Not only does it give an accurate relation between palpatory findings and the cardiac cycle, but provides information about inward movements as well.

Summary

The results of a kinetocardiographic investigation in 20 patients with fresh myocardial infarctions are described. The kinetocardiogram was abnormal in all cases. Large A waves, a large presystolic outward movement, and a large outward movement during ventricular systole were the main abnormalities found. These changes were found to be present immediately after occurrence of myocardial infarction. Alterations in the large A waves and in certain of the large systolic outward movements (notably pansystolic) were observed during the first thirty days and in the following four to nine month period. The diagnostic value of the method is not yet known, but more investigative work in this direction seems justified.

	Systolic outward movement:							
	A+	PSOM	E+	E—	ES	MS	PS	D+
1. KCG	90 %	50 %	55 %	40 %	20 %	70 %	35 %	45 %
2. KCG	85 %	60 %	25 %	35 %	15 %	65 %	25 %	35 %
3. KCG	85 %	55 %	30 %	35 %	30 %	85 %	35 %	30 %
4. KCG	75 %	40 %	35 %	35 %	35 %	80 %	15 %	40 %
5. KCG	56 %	50 %	40 %	35 %	25 %	69 %	19 %	38 %

Table 1

Relative frequency of the kinetocardiographic abnormalities found in 20 patients with fresh myocardial infarctions. A+, large A waves; PSOM+, large presystolic outward movement; E+, large E waves; E—, small E waves and small retraction; systolic outward movement: ES, early systolic; MS, mid-systolic; PS, pansystolic; D+, large D waves.

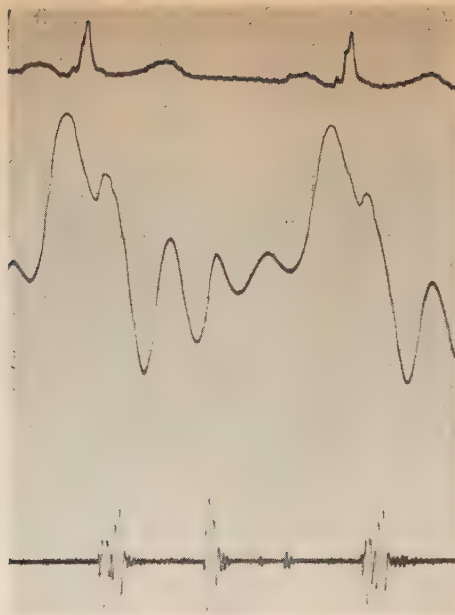


Fig. 1a KCG (K1/4) taken from a 39 year old man within 3 days after cardiac infarction showing a large A wave (A) and mid-systolic outward movements (MS). Blood pressure: 120/80 mm. Hg.

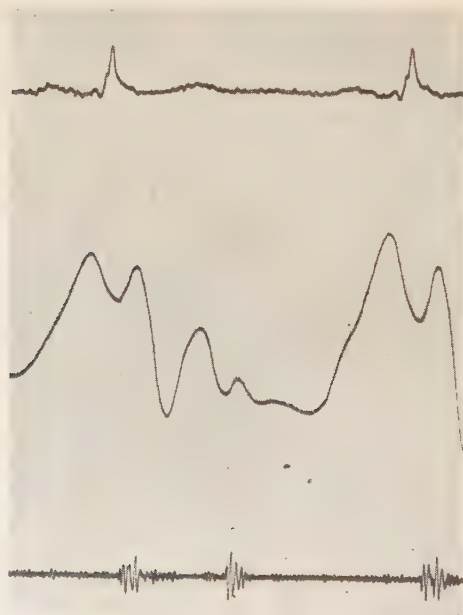


Fig. 1b 20 days after cardiac infarction. Deorease of the A wave.

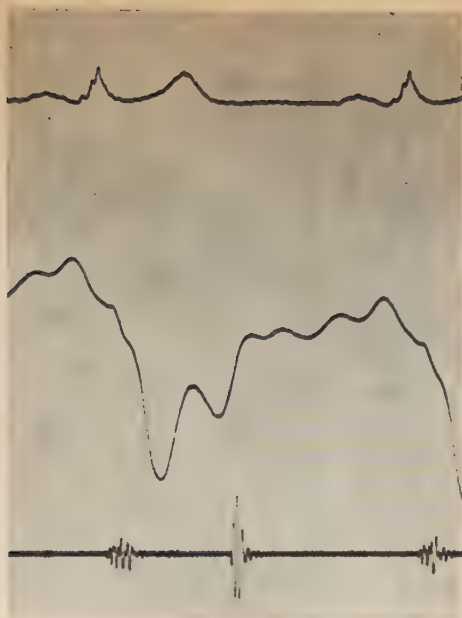


Fig. 1c 7 months after cardiac infarction. Normal A waves. Persistent mid-systolic outward movement.

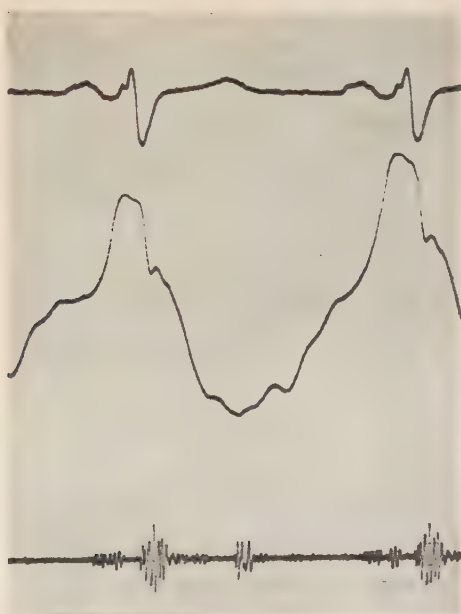


Fig. 2 KCG (2/4) taken from a 44 year old man 1 day after occurrence of cardiac infarction showing a large presystolic outward movement (PSM). Blood pressure: 110/80 mm. Hg.

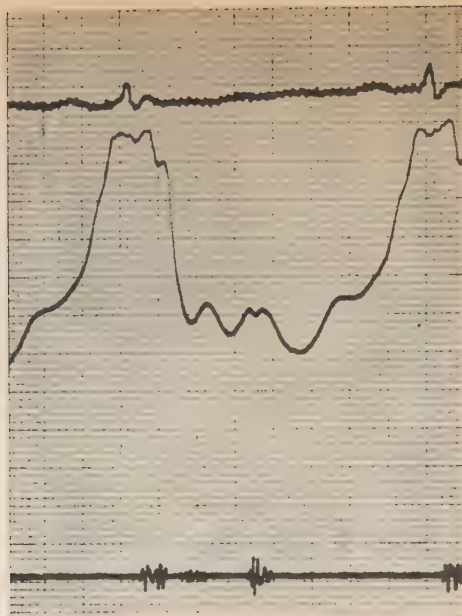


Fig. 3 KCG (K2/4) taken from a 58 year old man 23 days after occurrence of cardiac infarction showing a large presystolic outward movement (PSOM). Blood pressure: 150/80 mm. Hg.

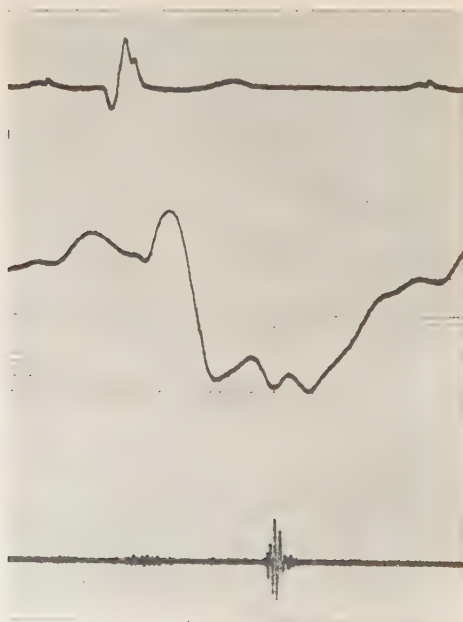


Fig. 4 KCG (4/4) taken from a 54 year old man 12 days after occurrence of cardiac infarction showing a large E wave (E). Blood pressure: 135/80 mm. Hg.

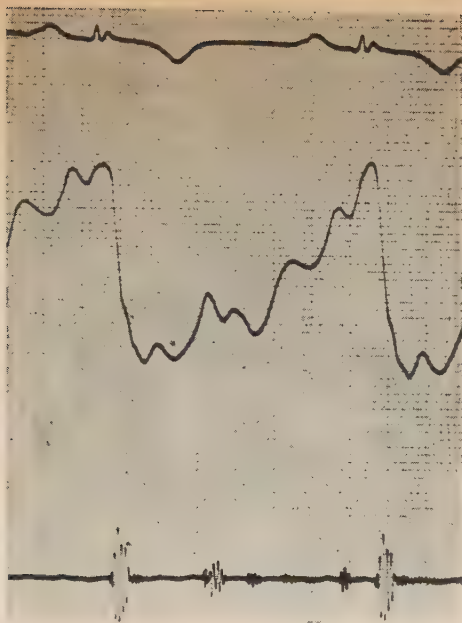


Fig. 5 KCG (K2/4) taken from a 47 year old man 29 days after occurrence of cardiac infarction showing small E waves and small retraction (E—). Blood pressure: 115/90 mm. Hg.

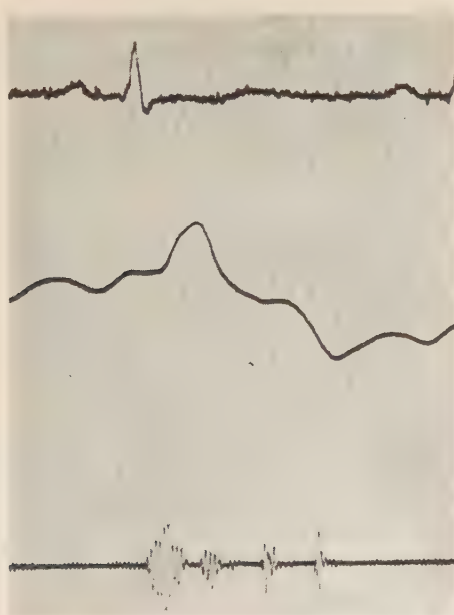


Fig. 6 KCG (K4/4) taken from a 61 year old woman 20 days after occurrence of cardiac infarction showing early systolic outward movements (ES). Blood pressure: 115/70 mm. Hg.

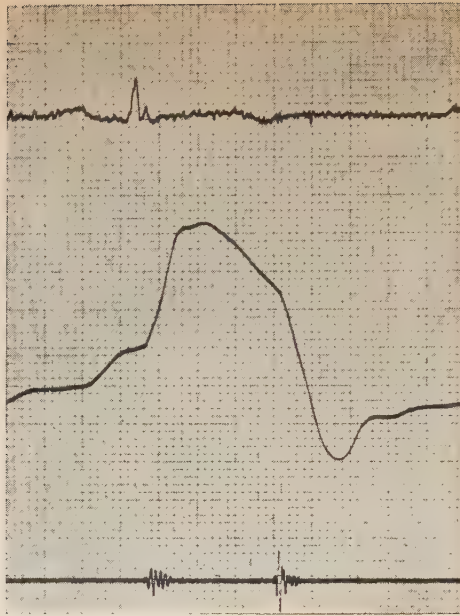


Fig. 7 KCG (K4/5) taken from a 53 year old man 22 days after occurrence of cardiac infarction showing pansystolic outward movements (PS). Blood pressure: 145/95 mm. Hg.



Fig. 8 KCG (K4/4) taken from a 65 year old man 3 days after occurrence of cardiac infarction showing large D waves (D). Blood pressure: 140/90 mm. Hg.

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